Trace-Gas Production and Consumption in Microbial Mats

Brad M. Bebout

The Ames Microbial Ecology/Biogeochemistry Research Lab has made contributions to determining the rates and conditions under which various trace gases are emitted and/or consumed by microbial mats and stromatolites. The most promising search strategy for the detection of life on extrasolar planets is the detection of possibly biogenic gases using infrared spectrometry. Space-based interferometers, such as the Terrestrial Planet Finder, should be able to resolve the spectra of several biologically important trace gases in the atmospheres of extrasolar planets, possibly within 10 to15 years. Therefore, it is important to provide a conceptual framework for the interpretation of the possible biogenicity of these gases.

Measurements of the production and consumption of reduced gases have been made under current conditions on the Earth, and conditions that are not present now but have existed in Earth's past. To date these measurements indicate that: (1) there is a significant escape of a variety of reduced gases from these communities, and (2) there is significant oxidation, but also significant production, of these gases in the surface (oxidized) layers of these communities. Of particular note is the finding of significant rates of methane production in the aerobic zone of microbial mats, because methanogenesis is thought to be an anaerobic process.

Measurements of trace-gas production and consumption have been made in field-incubated microbial mats, in stromatolites, and in samples returned to Ames. Over the past year, the capability to incubate mats under natural conditions has been significantly enhanced with the modification of a greenhouse on the roof of Building N239. This greenhouse has been fitted with ultraviolet-radiation-transparent acrylic to accommodate the importance of ultraviolet (UV) rays in the ecology of these communities. This greenhouse offers the capability to incubate mats under natural solar illumination, realistic water flows and temperatures, and atmospheres of variable gas composition.

In conjunction with the activities of the Early Microbial Ecosystems Module of the Ames Astrobiology Institute Team, the Biogeochemistry/Microbial Ecology Research Laboratory has participated in numerous field expeditions. Measurements of numerous important biogeochemical processes in microbial mats were made on these trips, including oxygenic photosynthesis, nutrient cycling, and nitrogen fixation.

Technology development continues to center on microsensor technology. In order to be able to better measure light (specifically plane irradiance) within photosynthetic microbial mats, a novel fiber-optic microsensor capable of making these measurements even within lithified (hard) microbial mats and stromatolites was developed.

Point of Contact: B. Bebout
(650) 604-3227
bbebout@mail.arc.nasa.gov

Synthesis of Organic Molecules in the Fracture Zone of Meteorite Impacts on Europa

Jerome G. Borucki, Bishun N. Khare

This work studies the synthesis of organic molecules that occurs as a result of meteorite impacts into planets with icy surfaces, such as Europa. Meteorite impacts into icy surfaces cause a large zone of fracturing under the impact crater. Very large voltages are generated during this fracturing, and that energy is, in effect, "stored" in the ice as electrostatic charges spread over a large area of the ice for substantial periods of time. Over time, the electrostatic charges can accumulate until a critical level ("the breakdown potential of ice") is reached, at which time electrical arcing occurs. In the presence of water-ice, methane, and ammonia, this arcing